Phase measurements in Aharonov-Bohm interferometers

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Abstract

Mesoscopic solid state Aharonov-Bohm interferometers (ABI) have been used to measure the "intrinsic" phase, α_D, of the resonant quantum transmission amplitude $t_D = -i|t_D|e^{i\alpha_D}$ through a quantum dot (QD), which is placed on one of the paths. In a "closed" interferometer, connected to two terminals, the electron current is conserved, and Onsager's relations require that the conductance G through the ABI is an even function of the magnetic flux $\Phi = \hbar c\phi/e$ threading the ABI ring. Therefore, if one fits G to $A + B\cos(\phi + \beta)$ then β only "jumps" between 0 and π, with no relation to α_D. After reviewing these topics in the first lecture, the second lecture uses theoretical models to derive three new results on this problem: (i) In many cases, we show that the measured G in the closed ABI can be used to extract both $|t_D|$ and α_D.[1] (ii) Additional terminals open the interferometer but then β depends on the details of the opening.[2] We present quantitative criteria (which can be tested experimentally) for β to be equal to the desired α_D: the "lossy" channels near the QD should have both a small transmission and a small reflection.[3] (iii) For the closed ABI, we find a general expression for the persistent current I_p at steady state, valid for the case where the electronic system is free of interactions except on the dot. The result is used to derive the modification in I_p brought about by coupling the QD to a phonon source. The magnitude of I_p is found to be enhanced in an appropriate range of the intensity of the acoustic source.[4]

References

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